



Significance of Gefersa Artificial Reservoir and its surrounding habitat for the conservation of avifauna, Northwestern Addis Ababa, Ethiopia

Hadis Tadele¹✉, Afework Bekele², Simeneh Admasu³

¹Medawelabu University, Bale-Robe, Ethiopia. Email: hadis.tadele1@gmail.com, phone- +251910363169, P.O.Box- 247, Fax: +251-22665 2519

²Department of Zoological Sciences, Addis Ababa University, Addis Ababa, Ethiopia

³African Wildlife Foundation Project Officer Debark, Ethiopia

✉Corresponding author

Medawelabu University, Bale-Robe,
Ethiopia
Email: hadis.tadele1@gmail.com

Article History

Received: 28 November 2019

Accepted: 12 January 2020

Published: January 2020

Citation

Hadis Tadele, Afework Bekele, Simeneh Admasu. Significance of Gefersa Artificial Reservoir and its surrounding habitat for the conservation of avifauna, Northwestern Addis Ababa, Ethiopia. *Species*, 2020, 21(67), 53-61

Publication License



© The Author(s) 2020. Open Access. This article is licensed under a [Creative Commons Attribution License 4.0 \(CC BY 4.0\)](https://creativecommons.org/licenses/by/4.0/).

General Note



Article is recommended to print as color digital version in recycled paper.

ABSTRACT

This study was carried out in Gefersa Artificial Reservoir and its surrounding habitat. Sampling sites were taken using stratified random sampling technique, where three habitats; Aquatic, grassland and woodland habitats were selected. Line and point transect methods were used to count birds based on habitat characteristics. Data were analyzed using SPSS and Excel software as well as

Shannon-weaver index of diversity. A total of 60 bird species consisting of four endemics were recorded. The aquatic habitat had high species richness and lowest species diversity during the study period. Variation in avian species richness and species abundance among the three habitats was significant ($F=6.43$, $df=14$, $P<0.05$) and ($F=16.06$, $df=14$, $P<0.05$), respectively. Generally, bird species richness and diversity including their distribution among the habitats in the reservoir was high. The current anthropogenic pressure in the areas is becoming a severe threat for the conservation of birds and their habitat. Therefore, it is highly recommended to develop proper land use and management plan to maintain the survival of this unique diversity and use it as a tourist destination for bird watchers.

Keywords: Avifauna, bird watchers, conservation, disturbance, Gefersa reservoir.

1. INTRODUCTION

Birds are important components of our ecosystem and play a major role in maintaining the natural balance in the food chain. They are widely distributing animals mainly occur on land, in sea and freshwater and virtually in every habitat, from the lowest deserts to the highest mountains and from the Arctic to Antarctica (Bird Life International, 2008). The latitudinal species have high abundance due to the availability of food which directly affects the level of fecundity (Dorst, 1971; Oindo et al., 2001). Distribution and abundance of water birds can be affected by several factors. Little change in physical, chemical or biological properties put forth intense effects on bird's habitats (Murphy et al., 1984). The nature of the surrounding landscape, particularly the presence and extent of arable land, is recognized to significantly influence the distribution of grassland bird communities (Atkinson et al., 2005).

The action of humans is also recognized as a critical overwhelming important factor that influences the natural distribution of birds (Stattersfield et al., 1998). Disturbed agricultural sites have known to support numerous bird species particularly both forest generalist and specialist birds, since, agricultural practices have occurred in areas that were formerly forested (Asasira and Pomeroy, 2008). Thus, human activities in modifying the natural environment are greatly impacting density and composition of the avian community. Birds are recognized as excellent indicators of biodiversity health as well as a particular ecosystem and its functioning (Gregory et al., 2003), because they are easily seen and assessed. Water birds can be used as indicators of wetland quality and parameters for assessing restoration success and regional biodiversity (Kumar and Gupta, 2009). They can be used as an important indicator to monitor environmental changes in carefully spotting their ecological diversity and sensitivity towards environmental changes (Bock, 1997; Jarvinen and Vaisanen, 1979; Kleinheinz et al., 2006). Therefore, it is essential to provide maximum efforts for biodiversity endowment documentation of a country. Designation of protected areas for the enhanced conservation of the threatened species including birds and other wild animals is necessary (EWNHS, 1996). It is essential to ensure local communities and stakeholders highest involvement to maximize their commitment for a long-term effective conservation success (Bird Life International, 2008). It is recognized that riparian forest parks surrounded by urban development to support significant number and diversity of wintering birds than similar forests in more rural landscapes due to improved food resources and microclimate conditions in urban landscapes (Atchison and Rodewald, 2006). Therefore, it is very indispensable to give highest conservation attention not only to maintain the survival of such charismatic bird species but also provide the impetus and economic investment for improved conservation of species and habitats through ecotourism development (Pez-Espinosa and Monteros, 2001). Therefore, this study intended to determine the significance of Gefersa artificial reservoir for improved avifauna conservation as an implication for avian tourism and other forms of ecotourism developments in the area located in the outskirts of Addis Ababa city.

2. MATERIALS AND METHODS

The study area

Gefersa artificial reservoir is located at 09°03'N 38°38'E, within 18 km distance from Addis Ababa in the West Shoa Zone at an elevation of 2760 masl (Fig. 1). The reservoir was first constructed in 1938 and then modified in 1954 to increase water demand of Addis Ababa city. It covers an area of about 5,700 ha. It is shallow in depth and stretches around 10 km between the mountains of Wechacha and Entoto (EWNHS, 1996). The area is attractive to a large number of water birds. The reservoir is fed by direct precipitation, runoff from the catchments and rivers from three directions. The water retention or reservation potential of this reservoir is 6,500,000 m³ (EWNHS, 1996). The amount of water reserved in the area varies from season to season highest during the late August to early December and the lowest during late February to May. The area is known as one of the important bird areas in Ethiopia with IBA Code of ET027. It has a rich diversity of highland birds especially those found in the Afro tropical biome (EWNHS, 1996).

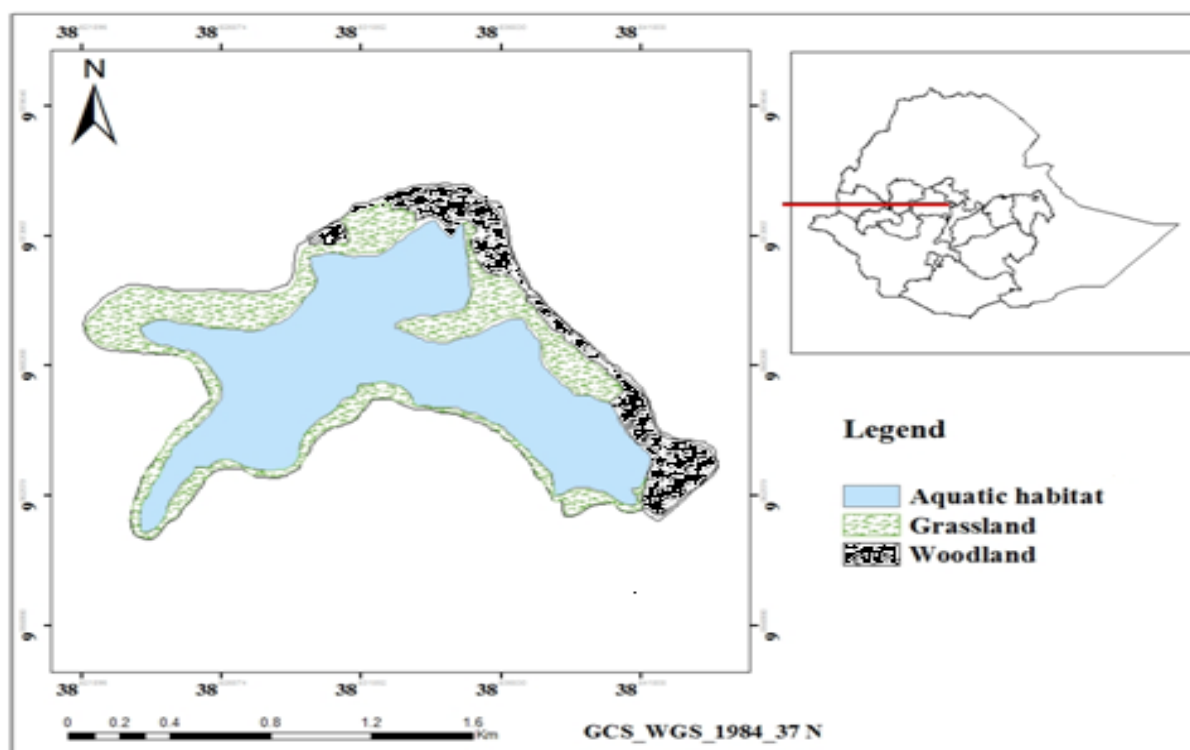


Figure 1 Location map of study area

Data collection and analysis

Data were collected during the dry season from mid-November 2014 to early January 2015). Repeated count was made in different habitat types (woodland, grassland and Aquatic habitats) of the study area to minimize bias and maximize accuracy. Point and line transect count methods were applied to collect data on the birds of the study area depending on the habitat type and suitability of the method (Buckland et al., 2001). Seven sample points around the periphery of the reservoir were located systematically based on the degree of suitability for counting and were used as a counting station for water birds (Froneman et al., 2001; Turner, 2003). In the selected stations, all positive identification and counting were carried out both by sight and call with a 150 m radius (Sutherland, 1996, Sutherland et al., 2004). In the grassland habitat, four transect lines were laid out and in the woodland habitat, five points count stations were selected for the bird count.

For standardization purposes, the overall survey was conducted between 6:00-10:30 in the morning and 15:00-18:00 in the afternoon when most birds were in their peak activity (Bennun and Howell, 2002). Observations were carried out to both sides of the line transects and point count stations with the help of binoculars.

The data collected was entered into excel spreadsheets for statistical analysis to examine species richness, community composition and abundance of species across the three habitat types. Comparison among bird communities was analyzed using similarity indices. Community structures or diversity of birds within the site was described in terms of Shannon-Weaver Diversity index (H') (Shannon and Weaver, 1949). Statistical analysis was conducted to see any variation among habitats in terms of species richness using independent sample t-test and One Way ANOVA.

3. RESULTS

A total of 60 bird species belonging to 28 families and 13 orders were recorded during the study period (Table 1). Ethiopian siskin (*Serinus nigricaps*), and Blue-winged Goose (*Cyanochen cyanoptera*) were endemic to Ethiopia where as Wattled Ibis (*Bostrychia carunculata*), White-Collared Pigeon (*Columba albitorques*) and Abyssinian Woodpecker (*Dendropicos abyssinicus*) were regionally endemic shared with Eritrea. In terms of conservation status, Blue-winged Goose was the only vulnerable species whereas the rest of the recorded species were least concern. From the total recorded species, 17 were migrant species especially from the Palearctic region and 48 bird species were resident ones (Table 1).

Table 1 Bird species recorded during the study period in the three habitat types (R- Resident in the country, E- Endemic to Ethiopia, EE- Endemic species shared with Eritrea, PM- Palearctic Migrants, PW- Breeds in the Palearctic and winters in the country, R/PW- Both resident and wintering population, V- Vulnerable).

Family	Common name	Scientific name	Status
Order Suliformes			
Phalacrocoracidae	White-breasted Cormorant	<i>Phalacrocorax lucidus</i>	R
	Reed (long-tailed) Cormorant	<i>Phalacrocorax africanus</i>	R
Order Pelecaniformes			
Ardeidae	Grey Heron	<i>Ardea cinerea</i>	R/PW
	Little Egret	<i>Egretta garzetta</i>	PW
	Black-headed Heron	<i>Ardea melanocephala</i>	R
Threskiornithidae	Wattled Ibis	<i>Bostrychia carunculata</i>	R/EE
	Glossy Ibis	<i>Plegadis falcinellus</i>	R
	African Sacred Ibis	<i>Threskiornis aethiopicus</i>	R
Pelecanidae	Great White Pelican	<i>Pelecanus onocrotalus</i>	R
Scopidae	Hamerkop	<i>Scopus umbretta</i>	R
Order Ciconiiformes			
Ardeidae	Cattle Egret	<i>Bubulcus ibis</i>	R/M
Order Accipitriformes			
Accipitridae	Yellow-Billed Kite	<i>Milvus egyptius</i>	R
	Black Kite	<i>Milvus migrans</i>	R/M
Order Falconiformes			
Accipitridae	African Fish Eagle	<i>Haliaeetus vocifer</i>	R
	Augur Buzzard	<i>Buteo augalis</i>	R
Order Charadriiformes			
Charadriidae	Three-Banded Plover	<i>Charadrius tricollaris</i>	R
	Common Ringed plover	<i>Charadrius hiaticula</i>	PM/PW
	Spur-Winged Lapwing (Plover)	<i>Vanellus spinosus</i>	R
Recurvirostridae	Black-Winged Stilt	<i>Himantopus himantopus</i>	R/PW
Scolopacidae	Ruuf	<i>Philomachus pugnax</i>	PW
	Green Sandpiper	<i>Tringa ochropus</i>	PW/PM
	Common Sandpiper	<i>Tringa glareola</i>	PW/PM
Order Columbiformes			
Columbidae	Dusky (Pink-Breasted) Turtle-Dove	<i>Streptopelia lugens</i>	R
	Red-Eyed Dove	<i>Streptopelia semitorquata</i>	R
	Speckled Pigeon	<i>Columba guinea</i>	R
	White-Collared Pigeon	<i>Columba albitorques</i>	R
Order Coliiformes			
Coliidae	Speckled Mouse bird	<i>Colius striatus</i>	R
Order Coraciiformes			
Alcedinidae	Half-Collared Kingfisher	<i>Alcedo semitorquata</i>	R
Order Piciformes			
Indicatoridae	Green Backed Honey Bird	<i>Prodotiscus zambesiae</i>	R

Picidae	Abyssinian Woodpecker	<i>Dendropico selachus</i>	R/E
Order Passeriformes			
Motacillidae	Yellow Wagtail	<i>Motacilla flava</i>	PM/PW
	White Wagtail	<i>Motacilla alba</i>	PM/PW
	Citrine Wagtail	<i>Motacilla citreola</i>	R
Corvidae	Red-Throated Pipit	<i>Anthus cervinus</i>	PM/PW
	Cape (Black) Crow	<i>Corvus capensis</i>	R
	Pied Crow	<i>Corvus albus</i>	R
Pycnonotidae	Dark-Caped (Black-eyed) Bulbul	<i>Pycnonotus tricolor</i>	R
Turdidae	Ground scraper Thrush	<i>Psophocichlalitsisi rupa</i>	R
	Mountain Thrush	<i>Turdus abyssinicus</i>	R
	Isabelline Wheatear	<i>Oenanthe isabellina</i>	PM/PW
Muscicapidae	Abyssinian Slaty Flycatcher	<i>Dioptrornischocolatinus</i>	R
	Moorland (Alpine) Chat	<i>Cercomela sordida</i>	R
	Ruppell's Robin-Chat	<i>Cossypha semirufa</i>	R
Laniidae	Common Stonechat	<i>Sexicola torquatus</i>	PM/PW
	Common Fiscal	<i>Lanius collaris</i>	R
	Streaky Seed-Eater	<i>Serinus striolatus</i>	R
Fringillidae	Brown-Rumped Seed Eater	<i>Serinus tristriatus</i>	R
	Ethiopian Siskin	<i>Serinus nigriceps</i>	R/E
Alaudidae	Thekla Lark	<i>Galerida theklae</i>	R
Phylloscopidae	Common Chiffchaff	<i>Phylloscopus collybita</i>	PM/PW
Nectariniidae	Tacazze Sunbird	<i>Nectarinia tacazze</i>	R
Estrildidae	Yellow-Bellied Waxbill	<i>Coccyzygiaquartinia</i>	R
Hirundinidae	Brown-throated(Plain) Martin	<i>Riparia paludicola</i>	R
Order Anseriformes			
Anatidae	Egyptian Goose	<i>Alopochena egyotiaca</i>	R
	African Black Duck	<i>Anas sparsa</i>	R
	Yellow-Billed Duck	<i>Anasandulata</i>	R
	Blue-Winged Goose	<i>Cyanochen cyanoptera</i>	R/EE/V
	Northern Shoveller	<i>Anas clypeata</i>	PW
	Northern Pintail	<i>Anas acuta</i>	PW
Order Podicipediformes			
Podicipedidae	Little Grebe	<i>Tachybaptus ruficollis</i>	R

The highest species number was recorded in the Aquatic habitat (28 species), followed by grassland habitat (24 species) and woodland habitat (20 species). The highest number of bird abundance was recorded in the Aquatic habitat of 693 individuals while the lowest was recorded in the woodland habitat of 60 individuals. Passeriformes constituted the predominant group, representing 38.3% (n=23) of the recorded species. The dominant families with the largest number of species were Anatidae 10% (n=6) and Muscicapidae 8.3% (n=5). Order Passeriformes had the highest number of families 11 (38%).

The species diversity was high ($H' = 2.76$) in the woodland habitat whereas the species diversity in the Aquatic habitat was lowest ($H' = 1.39$). Regardless of the highest species diversity in the woodland habitat, it was the aquatic habitat which had the highest bird abundance. In terms of species abundance and richness, there was a significant variation among habitats ($F = 16.06$, $df = 14$, $P < 0.05$) and ($F = 6.43$, $df = 14$, $P < 0.05$), respectively. In addition, it was the woodland habitat which had high species evenness ($E = 0.92$) followed by the grassland habitat ($E = 0.76$). Birds in the aquatic habitat had the lowest species evenness of the three habitat types (Table 2).

In the aquatic habitat, the abundance of Egyptian goose (*Alopochena egyotiaca*) was high 437 individuals (68%) followed by Northern Pintail (*Anas acuta*) 62 (9%) individuals and Yellow-Billed Duck (*Anasandulata*) 32 (5%) individuals (Fig. 2). However, there was no significant difference in the abundance of aquatic bird species ($t = 1.48$, $df = 25$, $P > 0.05$).

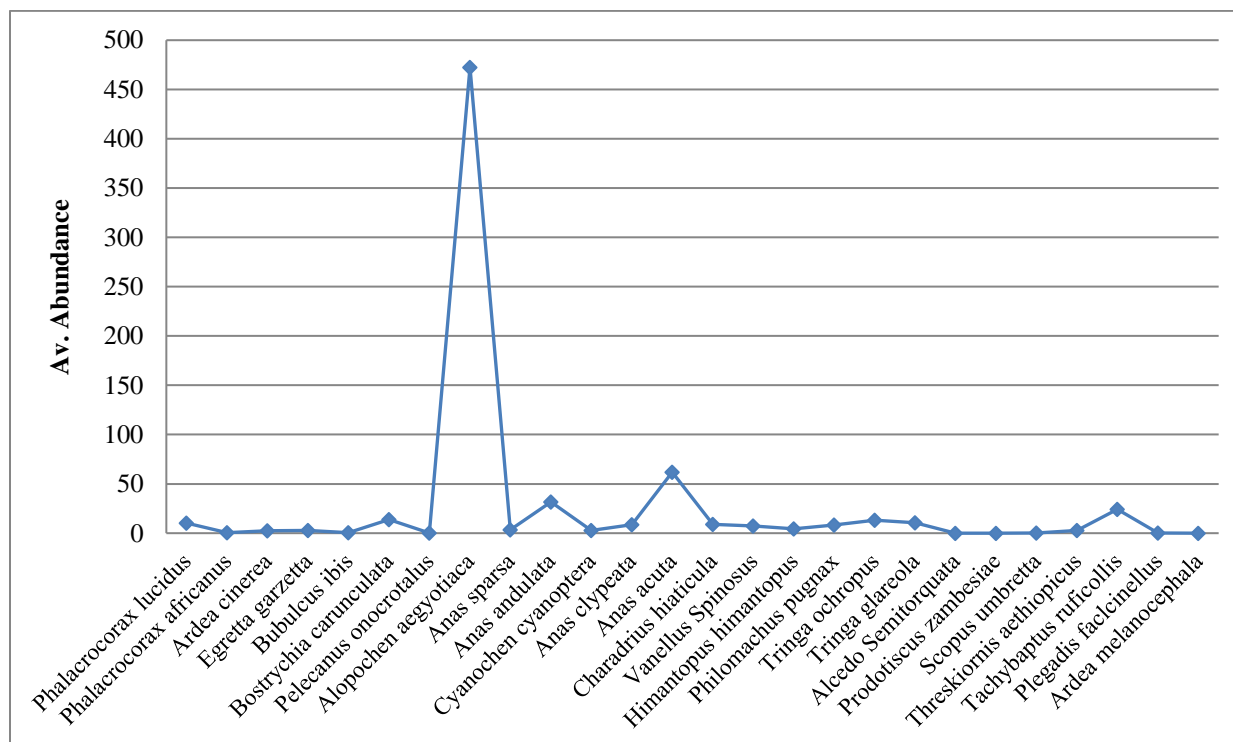


Figure 2 Average abundance of aquatic bird species

In the grassland habitat, Brown-throated Martin (*Riparia paludicola*) and White-Collared Pigeon (*Columba albitorques*) were the most abundant species in the habitat with 30 (24.4) and 19 (15.5) number of individuals respectively. There is a significant difference in the abundance of individuals among the grassland species ($t = 3.5$, $df = 23$, $P < 0.05$).

In the case of woodland birds, White-Collared Pigeon (*Columba albitorques*) 7 (12%) and Dusky Turtle-Dove (*Streptopelia lugens*) 6 (10%) were the most abundant. There was a significant difference in the abundance among the woodland birds ($t = 6.9$, $df = 19$, $P < 0.05$).

Table 2 Species diversity among habitats

Habitat type	Species richness	Species abundance	H'	H _{max}	E	D
Aquatic	28	4155	1.40	3.26	0.43	0.52
Grassland	24	491	2.41	3.18	0.76	0.88
Woodland	20	299	2.76	3.00	0.92	0.93

Abundance rank score using the encounter shows that in the aquatic habitat, there were more abundant bird species 13 (54.2%) followed by 5 (20.8%) common and 4 (16.7%) frequent species. In the grassland and woodland habitats, common bird species were more abundant than the other abundance category with 8 (42.1%) and 10 (62.5%), respectively (Table 3).

Table 3 Relative abundance of bird species in the three habitats

Abundance Rank					
Habitat	Rare	Uncommon	Frequent	Common	Abundant
Aquatic	1	1	4	5	13
Grassland	0	4	3	8	4
Woodland	0	1	2	10	3

The highest species similarity was obtained between grassland and woodland habitat ($SI = 0.55$). However, Aquatic habitat had no species similarity to the other two habitats ($SI = 0$).

4. DISCUSSION

The reservoir is among the recognized Important Bird Areas (IBAs) in Ethiopia due to its significance for the conservation of birds mainly for the Afrotropical biome birds and large aggregation of water birds (EWNHS, 1996). Although robust information on ecology and composition of birds in the area is needed the study has identified significant numbers of species. A total of 60 bird species with one vulnerable species were known to occur in the area. This proved that the area is very crucial for avian conservation as well as avitourism development for bird watchers in the outskirts of Addis Ababa. The observed richness might be due to the difference in vegetation structure or the presence of habitat diversity, as habitat structural difference or presence of diverse habitats does support diverse bird species (Dorst, 1971; Jacobs and Schloeder, 2001; Oindo et al., 2001).

Relatively, the Aquatic habitat had high species richness and high species abundance. This might be due to the high productivity of the aquatic habitat and associated characteristics. Froneman et al. (2001), have reported that availability of food resources, adequate shelter and breeding habitat are important factors that determine the species abundance and richness of one area. The presence of water birds in an area reflects the presence of fishes, amphibians, molluscs, aquatic insects and their larvae all of which are all good sources of food for water birds (Ali et al., 2013). In relation to the abundance of birds, aquatic habitats do not show any significant difference, whereas in the grassland and woodland habitats birds show significant variation in the abundance. Even though the aquatic habitat had the highest species richness, it had also lowest species diversity, whereas the woodland habitat which had lowest species richness had highest species diversity. This could be due to the highest species evenness in the woodland habitat and lowest species evenness in the aquatic habitat. On the other hand, the lowest species evenness in the aquatic habitat might due to the presence of Egyptian goose which had highest abundance than the other aquatic birds.

The area supports 17 species of birds which migrate from the Palearctic region. This shows that the area has a great potential for conservation of wintering birds, either they use the area for breeding or feeding ground during the winter season. Blue-winged Goose was vulnerable species and the rest of the other species were least concern. This indicates that if we give priority for the conservation of this area, we can contribute for conservation of the endemic and other related species. Grassland and woodland habitats have a large number of birds in common and higher species similarity than aquatic habitats. This can be considered due to the terrestrial characteristics of the two habitats in which terrestrial birds can easily move between the two habitats. However, most water birds do not have a common habitat with the terrestrial birds. It might be also due to the classification of aquatic birds for those birds which inhabit and feed in the water or at the edge of the aquatic habitat.

The reservoir has a higher number of water birds than grassland or woodland birds including the abundance of each water bird in the area. This shows that the area is very attractive for water birds and its water quality is considered at its best level. Custer and Osborne (1977) have also suggested that richness, abundance and activity of water birds in an area indicate the quality and complexity of the habitat and other interrelated organisms. The water level of lakes and reservoirs can fluctuate either on an annual or monthly basis due to seasonal change or climate-related influences (Bennun and Nasirwa, 2010). This results in the creation of different niches which then could have an interesting pattern of flora and fauna (Murugesan *et al.*, 2013). Water birds show a significant change in abundance and diversity (Bennun and Nasirwa, 2010). Informal interview and personal observation during the study period show that Gefersa reservoir water level decreases significantly within two to three months due to extensive usage of water for consumption by city dwellers. However, its impact on the abundance, distribution and diversity of fauna and flora especially on birds is not known. Therefore a detailed study needs to be carried out to determine the change in water volume and its impact on the water birds richness and diversity.

5. CONCLUSION

This study revealed the importance of Gefersa reservoir for the conservation of birds, especially for the conservation of water birds both migratory and residents species. The species composition, diversity, abundance and distribution vary across habitats associated with the individual species response to feeding behaviour and vegetation characteristics. Currently, the area is under the legal protection of Addis Ababa Water and Sewerage Authority, with a goal in mind to protect the areas water resources without regard to the presence of diverse avifauna. Even though the area is designated as IBA, there is a lack of effort on the regular assessment of avifauna endowment of the area for legal bird conservation and tourism development endeavours. In addition, high human pressure from the surrounding area with the rapid expansion of agriculture into the grassland and nearby sloppy habitats and increased livestock are putting pressure and becoming a major threat of the birds and their habitat. Due to this, some important birds which are sensitive to human disturbance are becoming the prime victims of this disturbance. Therefore, it is highly recommended to develop a proper land-use plan to maintain the survival of this unique habitat and Addis Ababa city as well as the surrounding

special zonal administration should include the area into their tourist map as one potential tourist destination, especially for bird watchers.

Author's contribution

Both authors contributed to this manuscript preparation. HT collected data of the bird survey, contributed to analyzing and interpreting the data, and writes the report. AB has read, edit and modify the manuscript.

Funding

This study was funded by Addis Ababa University including financial and materials support to accomplish the research works.

Acknowledgement

The first author of this publication would like to acknowledge Addis Ababa Water and Sewage Authority for providing permission to conduct this study in the reservoir and Addis Ababa University, Department of Zoological Science has provided financial support.

Conflict of Interest:

The authors declare that there are no conflicts of interests.

REFERENCE

1. Ali, A. M. S., Kumar, S. R. and Arun, P. R. (2013). Waterbird assemblage in rural ponds of Samakhiali region, Kutch district, Gujarat, India.
2. Asasira, J. and Pomeroy, D. (2008). The abundance of birds in Uganda's inhabited areas and the importance of pastoral areas. *Afr. J. Eco.* 46: 14-18.
3. Atchison, K. A. and Rodewald, A.D. (2006). The value of urban forests to wintering birds. *J. Nat. Ar.* 26: 280-288.
4. Atkinson, P. W., Fuller, R.J., Vickery, J. K., Conway, G. J., Tallowin, J. R. B., Smith, R. E. N., Hayson, K. A., Ings, J. C., Asteraji, E. J. and Brown, V. K. (2005). Influence of agricultural management, Sward structure and food resources on grassland field use by birds in lowland England. *J. Appl. Ecol.* 42: 932-942.
5. Bennun, L. and Nasirwa, O. (2010). Trends in water bird numbers in the Southern Rift Valley of Kenya. *Ostrich* 71: 220-226.
6. Bennun, L. A. and Howell, K. (2002). Birds. In Davies, G. (ed.), *African Forest Biodiversity: Field Survey Manual for Vertebrates*: 121-153. Earthwatch, Oxford, UK.
7. Bock, C. E. (1997). The role of ornithology in conservation of the American West. *The Condor* 99: 1-6.
8. Buckland, S. T., Anderson, D. R., Burnham, K. P., Laake, J. L. and Borchers, D. L. (2001). *Introduction to Distance Sampling: Estimating Abundance of Biological Populations*. Oxford University Press, Oxford.
9. Custer, T. W. and Osborne, R. W. (1977). Wading birds as biological indicators. Long Survey, US Fish and Wildlife service, Washington DC.
10. Dorst, J. (1971). *The Life of Birds, Vol. II*. Columbia University Press, New York. EWCA (Ethiopian Wildlife Conservation Authority) (2011). <http://www.ewca.gov.et/node/17>, Accessed on 24/12/2011.
11. Ethiopian Wildlife and Natural History Society (EWNHS) (1996). Important Bird Areas of Ethiopia: A First Inventory. Ethiopian Wildlife and Natural History Society. Addis Ababa.
12. Froneman, A., J. Mangnall, R. M. and Crowe, T. M. (2001). Water bird assemblages and associated habitat characteristics of farm ponds in the Western Cape, South Africa. *Biodiversity and Conservation* 10:251-270.
13. Jacobs, M. J. and Schloeder, C. A. (2001). *Impacts of Conflict on Biodiversity and Protected Areas in Ethiopia*. World Wildlife Fund Inc., Washington D.C.
14. Jarvinen, O. and Vaisanen, A. R. (1979). Changes in bird populations as a criterion of environmental changes. *Holark. Ecol.* 2:75- 80.
15. Kleinheinz, G. T., McDermott, C. M. and Chomeau, V. (2006). Evaluation of avian waste and bird counts as predictors of *Escherichia Coli* contamination at Door county, Wisconsin beaches. *J. Great Lakes Res.* 32: 117- 123.
16. Kumar, P. and Gupta, S. K. (2009). Diversity and abundance of Wetland birds around Kurukshetra, India. *Our Nature* 7:212-217.
17. Murphy, S., Kessel M. B., and Vining, L. J. (1984). Waterfowl population and limnological characteristics of Taiga ponds. *J. Wildl. Manage.* 48:1156-1163.
18. Murugesan, M., Chandra, R., Prusty, B. A. K. and Arun, P. R. (2013). Avifauna of the Oussudu Lake and its environs, Puducherry, India and conservation concerns. *Bird Populations* 12: 19-29.
19. Oindo, B. O, de By, R. A. and Skidmore, A. K. (2001). Environmental factors influencing bird species diversity in Kenya. *Afr. J. Ecol.* 39: 295-302.
20. Pez-Espinosa, R. L. and Monteros, L. (2001). Evaluating ecotourism in natural protected areas of La Paz Bay, Baja

- California Sur, México: ecotourism or nature-based tourism? *Biodiv. Conserv.* 11:1539-1550.
21. Stattersfield, A. J., Crosby, M. J. and Wege, D. C. (1998). *Endemic Bird Areas of the World; Priorities for Biodiversity Conservation*. Bird Life International, Cambridge.
22. Sutherland, W. J. (1996). *Ecological Census Techniques: A Hand Book*. Cambridge University Press, Cambridge. 336pp.
23. Sutherland, W. J., Newton, I. and Green, R. H. (2004). *Bird Ecology and Conservation: A Hand Book of Techniques*. Oxford University Press, New York.
24. Turner, W. R. (2003). Citywide biological monitoring as a tool for ecology and conservation in urban landscapes: the case of the Tucson bird count. *Landscape and Urban Planning* 65: 149-166.